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A. B. CONNER, DIRECTOR
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DIVISION OF PLANT PATHOLOGY AND PHYSIOLOGY

THE INFLUENCE OF MOISTURE AND TEMPERATURE ON COTTON ROOT ROT

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SYNOPSIS

Like other diseases, cotton root rot is influenced by environment. Two of the environmental factors, rainfall and temperature, strongly influence the occurrence and severity of the disease.

Root rot makes its appearance usually when the plants are six to eight inches tall and gradually increases in prevalence through the early portion of the growing season, during which soil moisture supplies and such rainfall additions as occur are at least adequate for this increase in root rot development.

In four out of the five years studied, a drought period occurred in mid-season. In the absence of rainfall, the soil moisture supply is depleted through natural losses and crop demands and is accompanied by a check in root rot spread. In case of a prolonged drought period, the disease becomes less and less active until it shows very little spread to healthy plants.

Fall rains are followed by renewed activity of the disease. This response of the disease to moisture additions is so marked and certain in its occurrence as to show conclusively the vital relationship between the disease and rainfall. In years like 1926, when no mid-season drought occurred, root rot continues active throughout the season with corresponding high total percentage of dead plants in the crop.

Temperatures, during all but the last two or three weeks of the growing season, are favorable for root rot. Although moisture conditions are usually favorable, root rot spread is decidedly checked by the lowered temperatures in late fall becoming the controlling factor, while during the rest of the season moisture is the limiting factor in the development and spread of the disease.

CONTENTS

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J. J. TAUBENHAUS AND B. F. DANA*

Nature and Importance of the Disease

Cotton root rot, a disease confined to Texas and neighboring states, has repeatedly been shown to be due to a microscopic organism, *Phymatotrichum omnivorum* (Shear) Duggar, which draws its nourishment from the root system of the cotton plant. In so doing, it destroys the tissues upon which it feeds, thereby causing the death of the plant. Anyone caring to examine the dying plant can easily observe with the naked eye the yellowish, thread-like strands of the parasite on the surface of the affected roots. This is in sharp contrast to the smooth roots of a healthy plant. Rain coming at a dry period in mid-season or other factors may stimulate the development of the disease. However, the parasite must be present in the field before such a thing as rainfall can act to increase the disease. Rain in mid-season really creates a condition favoring the spread of root rot and is not itself the cause of the disease.

In the blackland section of Central Texas, root rot is the limiting factor in the growth of many crops and seriously affects ornamental plants. Losses are estimated to vary from 300,000 to 600,000 bales of cotton annually, to which must be added serious losses to other crops, to arrive at a true estimate of the importance of the disease to Texas agriculture.

Phase of the Disease Studied

The present study is limited to the influence of climatic factors on the visible or above-ground manifestations of root rot in cotton. Since the above-ground symptoms of root rot are distinct and easily recognized, and since there is an absence of any similar disease in this region, the use of above-ground symptoms is thoroughly reliable in the identification of diseased plants.

Wilting is the principal symptom that shows the presence and progress of the disease and is usually delayed until the root system is very seriously involved. For this reason, death of the top follows wilting in such a large proportion of cases that wilting is the logical symptom to employ

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*This study has been carried out at Substation No. 5, Temple, Texas. Credit is due the Substation Superintendents, D. T. Killough (1923), A. B. Cron (1924), H. E. Rea (1925-1926), and Henry Dunlavy (1927), for the collection of meteorological data and aid in prosecution of the work. Credit is also due Mr. Jurgen Wulf for care and diligence in collecting field records and assistance in compilation of tabular data.

in any study of the epidemiology of the disease during the growing season.

Climatic Factors Studied

Rainfall, air humidity and temperature are the climatic factors most likely to influence the root rot disease during the growing season.

Rainfall is perhaps the principal single factor affecting soil moisture. In a malady such as cotton root rot, where only the root system is subject to direct attack of the parasite, soil moisture plays an important part in its development and progress. On account of the close relationship between rainfall and soil moisture there should be found a close correlation between rainfall and the appearance and spread of the trouble.

Air Humidity favors the development of many foliage diseases and is studied here for any possible indirect effect on root rot through its effect on the cotton plant. Because of the nature of root rot, air humidity must of necessity operate indirectly, if at all. The extreme susceptibility of cotton to root rot may be expected to obscure the influence of a minor factor.

Temperature is perhaps second only to moisture as a factor influencing cotton root rot. In the present study, air temperature data are used in the absence of soil temperature records. The air temperatures are reduced to weekly mean temperatures, which closely parallel, although they may not exactly coincide with, the soil temperatures at the same station. This is specially true of soil temperatures at the surface and at the six-inch depth.

Period Covered

This study covers five seasons, 1923-1927. The root rot data were collected during the intervening period between the first appearance of root rot and frost. Root rot development continues after frost, but any study based on above-ground symptoms must be concluded when the tops are killed by frost. Fortunately, the five-year period includes significant variations in rainfall, temperature and root rot for the different years and the various parts of the several growing seasons. The periodic variations of factors which influence root rot afford opportunity to determine the response of root rot to these variations.

METHODS OF STUDY

Gathering and Compiling Root Rot Data

The population studied varied in size for the different years but in each case comprised a representative portion of the cotton on the Station farm. The total plant population under observation for the years 1923, 1924, 1925, 1926 and 1927 was 19,863, 29,566, 32,366, 26,791 and 79,975, respectively, with a root rot population for the same years of 5803, 5431, 3188, 14,985 and 17,896. This represents a percentage of

the crop dying from the disease during these years of 29.0, 18.1, 9.8, 55.9 and 22.3.

The determination of the presence of root rot was based on above-ground symptoms and almost entirely on wilting. This symptom, while reliable in the field identification of diseased plants, also permits rapid examination of a field and facilitates the making of permanent records.

The fields under observation were examined every day and each diseased plant marked by a key letter indicating the date of wilting. At the end of the growing season a record was made for the whole season. This record included the total number of plants and the number of plants wilting each day for the season. These records are the basis for the tabulation and compilation of all root rot data found below.

In developing the root rot data it was soon apparent that daily intervals were so short as to permit many minor and insignificant variations. Interpretation of daily records in graph form was found unsatisfactory because of these minor variations which obscured the general trend of the disease. Accordingly, all root rot data as well as meteorological data are compiled on the basis of weekly intervals. The same interval is used for all data so that all results are strictly comparable. The weekly interval obliterates insignificant variations but is sensitive to those of importance.

The root rot data found in Table 1 are based on the total population of the field. The percentage of the total population dying each week of the growing season was computed. Also the percentage of total population dying is shown accumulated to weekly dates. This affords a ready comparison of the seriousness of the disease for the different years and for the different weeks of the growing season.

In a further study of the seasonal progress of root rot a different method of computation was used because of the different sized plant populations studied for each of the five years. The total root rot population for each year was considered as a basis for computing the percentage of this total which appeared each week and accumulated to the same weekly intervals. In separate columns in Table 2 are given the percentage of total root rot for each week and the accumulated percentage to the same weekly intervals. It is felt that the data for the different years are strictly comparable when computed in this way.

Gathering and Compiling Meteorological Data

The meteorological data have all been taken from the routine records of the successive Substation Superintendents. These daily meteorological records were made available for this study through the courtesy of Mr. Henry Dunlavy, present Substation Superintendent. Daily records are based on readings made with slight variations at 7:00 A. M. and 6:00 P. M.

Precipitation, temperature and humidity records for the entire year were used. The weekly basis of compilation was found very satisfactory for the development of the meteorological data. Figures for the whole

year are used to facilitate a study of the influence of climatic conditions preceding the appearance of root rot.

Rainfall data are presented in Tables 3 and 4. In Table 3, total weekly rainfall is given. In Table 4, the year's rainfall accumulated to the weekly intervals is given for the purpose of comparison with root rot data in Table 1. Humidity data are displayed in Table 5. Average daily relative humidity based on A. M. and P. M. readings was converted to average weekly humidity figures. As in the case of temperature and rainfall, the humidity records are presented for the entire year to enable study to be made of the influence of these factors outside of the crop season. Temperature data are presented in Table 6. Daily mean temperatures were first computed from maximum and minimum readings. From these were calculated weekly mean temperatures for the entire year. The weekly mean temperature portrays the general temperature level and eliminates the daily fluctuations which probably have little significant influence on the disease.

THE INFLUENCE OF RAINFALL

Root Rot Losses

Losses from root rot are dependent mainly on the amount of rainfall and the season at which it comes. No other single factor controls the severity of the disease to the extent that rainfall or precipitation affects it.

Something of the importance of this factor may be gathered from a study of Figure 1, which is based on the data presented in Tables 1 and 4. The curves for precipitation in this case start at a point indicating the total rainfall from January 1 to the time of first root rot appearance. From the initial point, the curves for the several years show the accumulated rainfall to the weekly intervals throughout the remainder of the growing season.

Above the precipitation curves in Figure 1, are presented curves for the same five years showing the accumulated percentage of total field population dying from root rot calculated to weekly intervals throughout the growing season. The final point of each curve shows the percentage of the total crop dying from root rot for that year.

The most striking relation between rainfall and the severity of root rot is shown in the year 1925. Accumulated rainfall from January 1 to June 9 was just a little over six inches. This, in comparison with other years, was very low. But little additional moisture was received until September. That the initial and subsequent supply of moisture was not sufficient to favor root rot development is shown by the low total percentage of root rot for the season with less than ten per cent of the population dying.

In contrast with 1925, the year 1926 showed the highest accumulated rainfall at the beginning of the season. This initial moisture supply, together with the additions during the growing season, permitted the continued development of root rot throughout the entire season. At the

end of the growing season, nearly fifty-six per cent of the population had died.

Between these two years which represent extremely dry and extremely wet years lie the other three years which represent the range found in average years. It should be noted that rainfall at the end of the season in 1927 exceeded that for 1926, but the increase came so late in the season that it did not affect the total amount of root rot for that season. The figures presented in Table 1 show that root rot in all but very dry years is a very serious disease, causing from fifteen to thirty per cent dying in the crop. In very wet years this may number over fifty per cent of the population of the field.

No additional data are necessary to emphasize the losses occasioned by killing of so many plants in the field. Certainly many of the plants die before they have produced a full crop, and a large proportion are dead before they reach the producing age.

Seasonal Occurrence of Root Rot

That rainfall or moisture is a critical factor is further shown in Figure 2. Data upon which these curves are based are found in Tables 2 and 3. The rainfall data in Table 3 are calculated in total inches per week for the entire year. Curves in Figure 2 show rainfall for that part of the growing season when root rot is active.

Root rot data assembled in Table 2 are calculated in percentage of total dead plants dying by weeks. This method of treatment serves to bring out better the relationship of climatic factors to root rot. The dead plant population is analyzed to determine the season and proportion of the whole root rot population dying each week. This method of treatment eliminates inequalities caused by unequal population for the different years.

The curves prepared in Figure 2 show the rainfall and root rot separately for each of the five years, 1923 to 1927. This analysis serves to clarify the evidence that moisture is a critical factor in root rot development. The level of the curves for each week shows the total precipitation and the percentage of total root rot population noted that week.

Early Season Influence: The curves for the different years show that root rot continues to increase for a time after its first appearance. A certain moisture supply accumulates prior to planting. The demands of the growing crop increase to a point where the supply becomes limited and the crop growth is at least slowed down. It is up to this point that root rot spreads and increases. This portion of each year's curves shows a more or less gradual rise without any close relation to the rainfall for this period.

Mid-season Influence: The rainfall curve for every year except 1926 shows a mid-season period of low rainfall. This mid-season drought period, in every case, checks the increase of root rot and in 1923, 1924, and 1927 was followed by a short period of inactivity. The effect in

1925 is similar, but root rot did not entirely cease its activity. The fact that the disease all but ceases to spread during this drought period emphasizes the fact that moisture is a limiting factor. This relationship is further emphasized when root rot is stimulated to renewed activity by fall rains.

Late Season Influence: The several years, with the exception of 1926, show a decided peak of rainfall during September or early October. In every case a distinct increase of root rot follows the peak of rainfall. There are thus presented two very strong cases showing that rainfall is a primary factor in the epidemiology of the disease and that this factor operates freely during the greater part of the growing season. Further examination should perhaps be made to determine the presence or absence of any modifying factors. It is apparent, however, that nearly all factors that may influence the disease are either favorable or of minor importance and allow moisture to govern the rise and fall of infection during the main part of the growing season.

The root rot curves are cut off at the frost date, which comes earlier in some years than others. After the frost date, root rot may continue to spread, but the presence of the disease can only be determined by root examination. The results of such examinations can hardly be compared directly with records of disease based on wilting or above-ground symptoms only. A further study is to be made of late fall and winter spread of root rot for comparison with the present study.

A Modifying Factor

The downward dip in the root rot curves, Figure 2, just prior to the frost date is more abrupt and pronounced than one would expect from the rainfall curves. The curve for 1925 is a good illustration of this. The amount of rainfall would justify at least the maintenance of the level in the root rot curve. Instead there is an abrupt drop. This is also apparent in the curves for the other years.

The apparent exception to this in the sharp upturn of the curve in 1923 is due to the inclusion for that year of a number of records made by root examination after frost had killed the plants. For this reason, this part of the curve cannot be compared with curves for other years.

The decrease in root rot spread in late fall is so pronounced as to be apparent to the casual observer. This behavior indicates the entrance of another factor influencing root rot which, in effect, neutralizes the rainfall or moisture factor. This factor proves to be temperature and a discussion of it will be taken up below following a discussion of air humidity.

THE INFLUENCE OF AIR HUMIDITY

While air humidity plays a very important part in the development of foliage-infesting diseases, it can only influence a root infesting disease indirectly by its effect on the parts of the plant above ground. It is with the idea of discovering any such indirect effect that a study of the humidity factor has been made.

Air humidity data are presented in Table 5. The same weekly intervals are used throughout the study for the same years so that a direct comparison may be made in all cases. Daily records were first gathered and from these weekly average relative humidity figures computed. In Figure 3, root rot curves are compared with the humidity curves for the same years.

An examination of the early season portions of the curves shows that there is a slight decline in the humidity level at the same time that the root rot severity increases. Curves for other portions of the year fail to show any direct relation between humidity and development of the disease. The absence of apparent relationship between air humidity and root rot is probably due in part to the fact that root rot requires an incubation period of one to three weeks after infection before symptoms appear. Humidity depends on a number of varying factors which may change many times during this incubation period.

THE INFLUENCE OF TEMPERATURE

An optimum temperature is one of the cardinal requirements for a vigorous growth of any plant or animal. Since cotton root rot is caused by a microscopic plant, temperature must influence its development. Soil temperatures are much to be desired for a study of the activities of a parasite that spends its lifetime below the soil surface. Unfortunately, air temperatures only are available for this study.

Weekly mean air temperatures have been computed for the entire five-year period and appear in Table 6. By reducing to weekly mean temperature, daily variations characteristic of air temperature are eliminated. These figures closely parallel soil temperatures. The fact that weekly mean air temperatures do not exactly coincide with weekly mean soil temperatures taken at a level where root rot works does not make the air temperature less valuable in the present study, because the difference between the two can be only a few degrees at the most.

In Figure 4, weekly mean air temperature curves are compared with the same root rot curves as appear in Figures 2 and 3. A study of these curves shows that from June 1 to October 1, temperatures are favorable for root rot development. During this period, there is a marked uniformity in the temperature level for each of the five years. The temperature which ranges from slightly below to slightly above 80 degrees Fahrenheit at least permits the development of root rot in a very severe form, as shown by the level of the root rot curve for portions of this period.

During October, however, there is a sharp drop in the temperature curves, reaching fifty degrees F. early in November in all but the 1927 season, where the temperature drop is less extreme and longer delayed. The root rot curves correspond rather closely with the temperature curves for the October period.

A better appreciation of the influence of temperature can be gained from a study of Figure 5 where air temperature and rainfall are com-

pared with root rot. In 1923, 1924, 1925 and 1926, the rainfall in September and early October is sufficient to produce a greater volume of root rot or to sustain that volume at a higher level if it were not for the unfavorable influence of the lowered temperatures of October and November.

For 1923 the moisture factor in September was favorable for greater development of root rot in October, but for the deterrent action of the sharply falling temperatures. The same is more true of 1925, where depressed temperature causes a like decrease in root rot.

It is worthy of note that any action of lowered temperatures on root rot comes so late in the season as to be of little economic importance. Plants dying in late September and October would probably have the yield and quality of the lint damaged but little. It is the dying of immature plants that cuts the yield and quality of the crop roughly in proportion to the earliness at which the plants die. The temperature level, during the critical months, is seen to be entirely favorable to the development of the disease.

SUMMARY

Three climatic factors, rainfall, air humidity and temperature, have been studied to determine the influence of each on the root rot disease. Of the three factors, rainfall is outstanding in its importance. Humidity is seen to have no direct influence. Temperature for the crop-producing portion of the season is seen to be favorable to the development of the disease. Toward the end of the growing season, lowered temperatures reduce root rot severity in spite of favorable moisture.

A further analysis of the data reveals that an adequate supply of moisture at the early part of the season favors development of the disease regardless of the rainfall additions. In mid-season, however, there usually occurs a drought period which checks root rot, and in three out of the five years under study, spread of the disease was completely stopped for a considerable period.

In 1926, no mid-season drought occurred, and root rot continued to develop throughout the season with the result that more than fifty per cent of the plant population died. The suppression of root rot in those years when the soil moisture was limited and its continued development in a year of abundant moisture show that rainfall is a very critical factor and actually controls mid- and late-season development of the disease. The importance of the moisture factor is further shown by the increase of root rot following the advent of September rains.

Favorable temperature for root rot is seen to occur during the crop-producing portion of the season. That is, the temperature is favorable for development of the disease to a high degree of severity. In September and October, however, lowered temperatures become the limiting factor and cause a sharp reduction. This check in the disease occurs too late in the season to lessen its destructiveness, because plants dying at this time have already produced a crop which is not greatly injured by such delayed death of the plant.

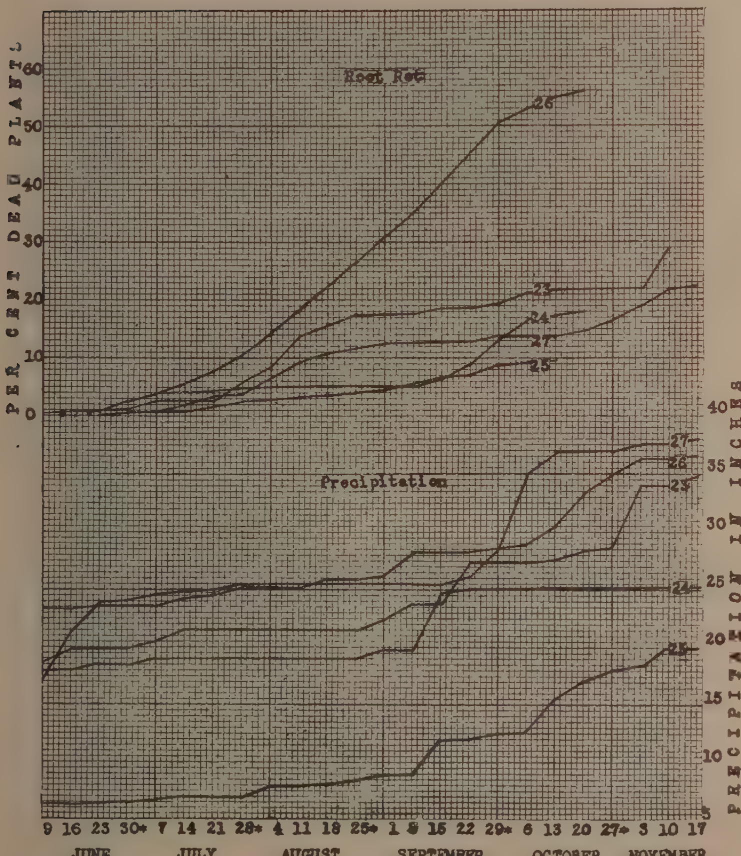

Fig. 1.—Accumulated precipitation and per cent of root rot on Substation No. 5, Temple, Texas, 1923-1927, inclusive. Precipitation curves start at a point showing accumulation of rainfall from January 1 to June 9 and indicate weekly additions throughout the remainder of the growing season. The root rot curves show the per cent of total plant population dying accumulated to weekly intervals (See Tables 1 and 4).

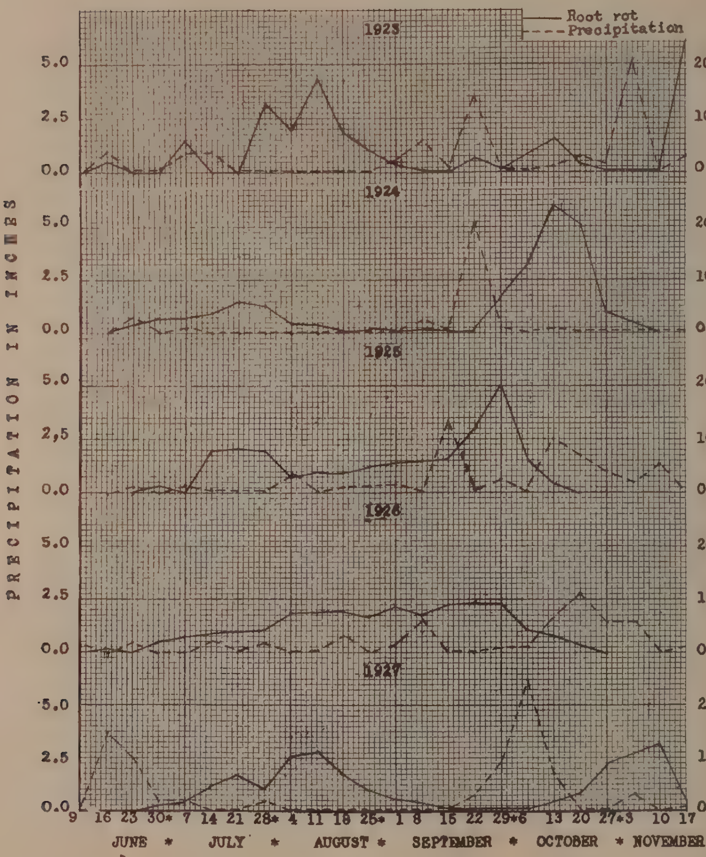

Fig. 2.—The per cent of the total season's root rot which appeared each week after the first occurrence of the disease and continuing until frost compared with rainfall in inches by weeks for the same period (See Tables 2 and 3).

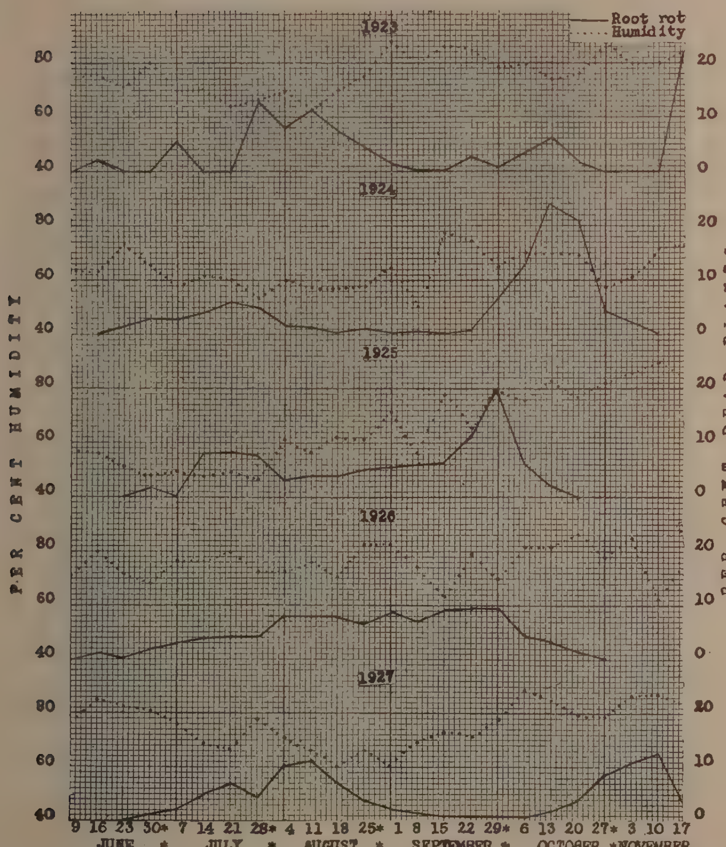

Fig. 3.—Weekly average relative humidity, 1923-1927, inclusive, at Temple, compared with the per cent of total season's root rot appearing each week extending from the first root rot appearance until frost (See Tables 2 and 5).

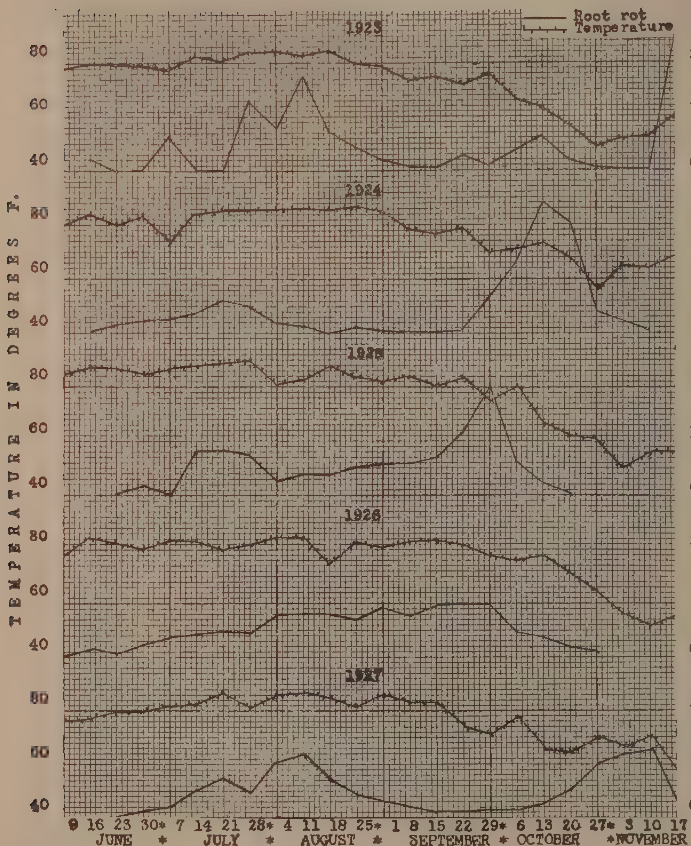

Fig. 4.—Weekly mean temperatures, 1923-1927, inclusive, at Temple compared with the per cent of the total season's root rot appearing each week of the season (See Tables 2 and 6).

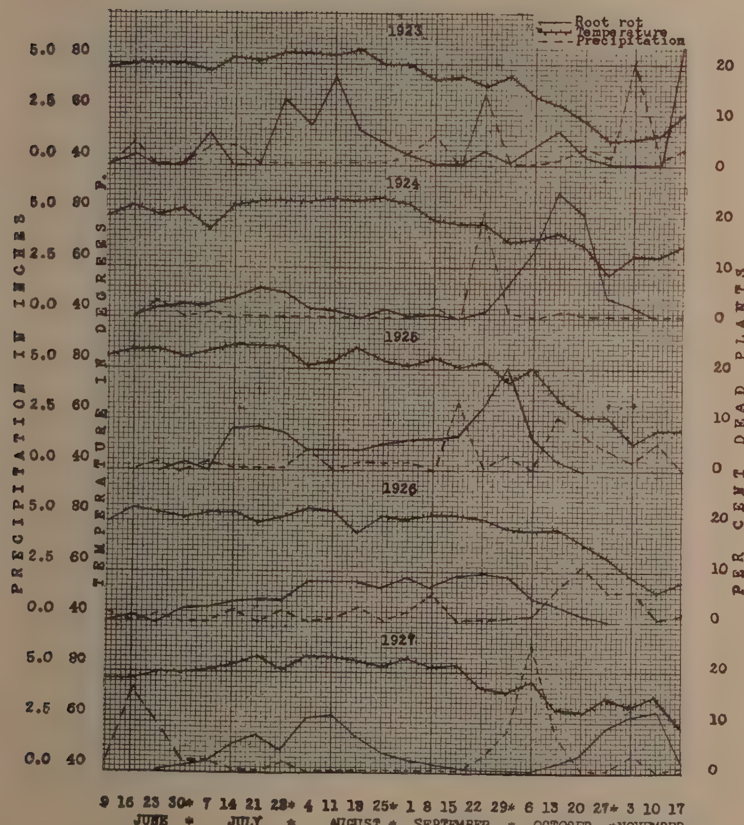

Fig. 5.—Comparison of per cent of total season's root rot by weeks, weekly precipitation in inches and weekly mean air temperature at Substation No. 5, Temple, Texas, 1923-1927, inclusive (See Tables 2, 3 and 6).

Table 1.—Per cent of total plants on Substation farm dying by weeks and per cent dead accumulated to the same weekly intervals. Data collected on Substation No. 5, 1923-1927

Week Ending	1923 Per Cent Dying		1924 Per Cent Dying		1925 Per Cent Dying		1926 Per Cent Dying		1927 Per Cent Dying	
	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week
June 16	.63	.63	.06	.06	.....	.....	.39	.39	.....	.....
June 23	.....	.....	.33	.39	.....	.....	1.18	1.57	.17	.17
June 30	.....	.....	.46	.85	.11	.11	1.76	3.33	.43	.60
July 7	1.68	2.31	.52	1.37	.05	.16	2.08	5.41	1.12	1.72
July 14	.....	.....	.79	2.16	.77	.93	2.27	8.68	1.51	3.23
July 21	.....	.....	1.10	3.26	.82	1.75	2.39	10.07	1.07	4.30
July 28	3.74	6.05	.99	4.25	.76	2.51	4.07	14.14	2.36	6.66
Aug. 4	2.40	8.45	.33	4.58	.31	2.82	4.17	18.31	2.56	9.22
Aug. 11	5.60	14.05	.25	4.83	.40	3.22	4.33	22.64	1.62	10.84
Aug. 18	2.14	16.19	.14	4.97	.36	3.58	3.73	26.37	.85	11.69
Aug. 25	1.29	17.48	.02	4.99	.50	4.08	4.74	31.11	.61	12.30
Sept. 1	.05	17.53	.004	4.99	.55	4.63	3.96	35.07	.32	12.62
Sept. 8	.01	17.54	.004	5.00	.61	5.24	5.11	40.18	.17	12.79
Sept. 15	.02	17.56	.....	.....	.64	5.88	5.32	45.50	.20	12.99
Sept. 22	.78	18.34	.18	5.18	1.18	7.06	5.19	50.69	.15	13.14
Sept. 29	.28	18.62	1.20	6.38	2.00	9.06	2.46	53.15	.003	13.14
Oct. 6	.87	19.49	2.44	8.82	.59	9.65	1.93	55.08	.41	13.55
Oct. 13	1.69	21.18	4.43	13.25	.20	9.85	.88	55.96	.90	14.45
Oct. 20	.52	21.70	3.79	17.04	.....	.....	.....	.....	2.10	16.55
Oct. 27	.....	.....	.74	17.78	.....	.....	.....	.....	2.47	19.02
Nov. 3	.....	.....	.35	18.13	.....	.....	.....	.....	2.87	21.89
Nov. 10	.....	.....	.....	.....	.....	.....	.....	.....	.45	22.34
Nov. 17	7.33	29.03	.....	.....	.....	.....	.....	.....		

Table 2.—Per cent of total root rot population dying by weeks and accumulated to the same weekly intervals. Data secured on Substation No. 5, Temple, Texas, 1923-1927

Week Ending	1923 Per Cent Dying		1924 Per Cent Dying		1925 Per Cent Dying		1926 Per Cent Dying		1927 Per Cent Dying	
	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week	During Week	During Season to Week
June 16	2.2	2.2	.3	.3	....	....	....	....	..	....
June 23	....	....	1.8	2.1	....	....	.7	.7	......	....
June 30	....	....	2.5	4.6	1.1	1.1	2.1	2.8	.8	.8
July 7	5.8	8.0	2.8	7.4	.5	1.6	3.2	6.0	1.9	2.7
July 14	....	....	4.3	11.7	7.8	9.4	3.6	9.6	5.0	7.7
July 21	....	....	6.0	17.7	8.3	17.7	4.1	13.7	6.7	14.4
July 28	12.8	20.8	5.4	23.1	7.7	25.4	4.3	18.0	4.8	19.2
Aug. 4	8.2	29.0	1.8	24.9	3.2	28.6	7.3	25.3	10.5	29.7
Aug. 11	17.3	46.3	1.3	26.2	4.1	32.7	7.5	32.8	11.5	41.2
Aug. 18	7.3	53.6	.8	27.0	3.7	36.4	7.7	40.5	7.2	48.4
Aug. 25	4.4	58.0	.9	27.9	5.1	41.5	6.6	47.1	3.9	52.3
Sept. 1	1.6	59.5	.2	28.1	5.6	47.1	8.5	55.6	2.7	55.0
Sept. 8	.5	60.1	.2	28.3	6.2	53.3	7.1	62.7	1.4	56.4
Sept. 15	.7	60.8	.1	28.4	6.4	59.7	9.2	71.9	.8	57.2
Sept. 22	2.7	63.5	1.0	29.4	12.0	71.7	9.4	81.3	.9	58.1
Sept. 29	1.0	64.5	6.5	35.9	20.3	92.0	9.3	90.6	.6	58.7
Oct. 6	3.0	67.5	13.3	49.2	6.0	98.0	4.4	95.0	.2	58.9
Oct. 13	5.7	73.2	24.1	73.3	2.0	100.0	3.5	98.5	1.8	60.7
Oct. 20	1.8	75.0	20.7	94.0	....	....	1.5	100.0	4.0	64.7
Oct. 27	....	....	4.1	98.1	....	....	....	....	9.4	74.1
Nov. 3	....	....	1.9	100.0	....	....	....	....	11.1	85.2
Nov. 10	....	....	....	....	....	....	....	....	12.8	98.0
Nov. 17	25.0	100.0	....	....	....	....	....	....	2.0	100.0

Table 3.—Precipitation by weeks at Temple, 1923-1927*

Week Ending	Precipitation					Week Ending	Precipitation				
	1923	1924	1925	1926	1927		1923	1924	1925	1926	1927
January 7	......	.06	.01	1.71	......	July 7	.83	.28	.30	......	.53
January 14	......	.07	.66	.01	.50	July 14	.94	......	.21	.67	.05
January 21	.15	.18	.71	4.04	.89	July 21	......	......	......	.15	......
January 28	.35	1.67	......	.46	.48	July 28	.03	......	......	.58	.69
February 4	1.22	.01	......	.01	.15	August 4	......	......	.96	......	......
February 11	1.53	1.00	.03	......	3.46	August 11	......	......	......	.07	......
February 18	1.27	1.14	......	.18	.21	August 18	......	......	.23	.75	......
February 25	1.40	1.77	.14	......	......	August 25	.16	......	.38	.02	......
March 3	.22	.49	......	......	.82	September 1	.59	.61	.34	.49	08
March 10	.37	1.05	......	3.94	1.03	September 8	1.48	......	......	1.86	.03
March 17	.12	.85	......	.18	.09	September 15	......	5.16	3.12	.01	......
March 24	......	.69	......	.38	1.42	September 22	3.67	.21	......	......	.84
March 31	1.80	.18	......	1.98	.13	September 29	......	......	.64	.22	2.13
April 7	.07	.04	......	.16	.01	October 6	......	.10	.15	.28	6 55
April 14	3.89	1.03	.01	1.76	1.59	October 13	.20	......	2.62	1.75	1.85
April 21	2.28	.08	......	3.39	2.40	October 20	.71	......	1.75	2.88	......
April 28	.82	1.74	1.23	.62	.09	October 27	.36	......	1.01	1.35	......
May 5	.07	.25	.76	1.29	.64	November 3	5.22	.04	.51	1.54	.75
May 12	.45	.74	1.04	......	1.28	November 10	......	.05	1.37	......	......
May 19	.56	1.33	.11	.88	1.01	November 17	.80	.03	.04	.24	.19
May 26	.03	1.91	1.44	......	.84	November 24	......	1.13	......	......	......
June 2	.27	1.71	......	1.81	......	December 1	.67	......	.10	......	......
June 9	1.81	......	......	.36	.29	December 8	1.35	.40	......	1.56	.43
June 16	1.01	......	......	......	3.97	December 15	5.46	......	.48	.37	.38
June 23	......	.77	.23	.48	2.40	December 22	1.37	.07	.02	.98	......
June 30	......		08	..	.36	December 29		75	..	.80	.87

*Calculated trom daily meteorological records at Substation No. 5

Table 4.—Precipitation at Temple, 1923-1927, accumulated to weekly intervals

Week Ending	Inches rainfall accumulated to weekly dates					Week Ending	Inches rainfall accumulated to weekly dates				
	1923	1924	1925	1926	1927		1923	1924	1925	1926	1927
January 7	....	.06	.01	1.71	....	July 7	20.52	19.04	6.75	....	24.59
January 14	....	.13	.67	1.72	.50	July 14	21.46	....	6.96	24.31	24.64
January 21	.15	.31	1.38	5.76	1.39	July 21	....	....	....	24.46	....
January 28	.50	1.98	....	6.22	1.87	July 28	21.49	....	....	25.04	25.33
February 4	1.72	1.99	....	6.23	2.02	August 4	....	....	7.92	....	....
February 11	3.25	2.99	1.41	....	5.48	August 11	....	....	....	25.11	....
February 18	4.52	4.13	....	6.41	5.69	August 18	....	....	8.15	25.86	....
February 25	5.92	5.90	1.55	....	....	August 25	21.65	....	8.53	25.88	....
March 3	6.14	6.39	....	....	6.51	September 1	22.24	19.65	8.87	26.37	25.41
March 10	6.54	7.44	....	10.35	7.54	September 8	23.72	....	....	28.23	25.44
March 17	6.63	8.29	....	10.53	7.63	September 15	....	24.81	11.99	28.24	....
March 24	....	8.98	....	10.91	9.05	September 22	27.39	25.02	....	....	26.28
March 31	8.93	9.16	....	12.89	9.18	September 29	....	....	12.63	28.46	28.41
April 7	8.50	9.20	....	13.03	9.19	October 6	....	25.12	12.78	28.74	34.96
April 14	12.39	10.23	1.56	14.81	10.78	October 13	27.59	....	15.40	30.49	36.81
April 21	14.67	10.31	....	18.20	13.18	October 20	28.30	....	17.15	33.37	....
April 28	15.49	12.05	2.79	18.82	13.27	October 27	28.66	....	18.16	34.72	....
May 5	15.56	12.30	3.55	20.11	13.91	November 3	33.88	25.16	18.67	36.26	37.56
May 12	16.01	13.04	4.59	....	15.19	November 10	....	25.21	20.04	....	....
May 19	16.57	14.37	4.70	20.99	16.20	November 17	34.68	25.24	20.08	36.50	37.75
May 26	16.60	16.28	6.14	....	17.04	November 24	....	26.37	....	....	....
June 2	16.87	17.99	....	22.80	....	December 1	35.35	....	20.18	....	....
June 9	18.68	....	....	23.16	17.33	December 8	36.70	26.77	....	38.06	38.18
June 16	19.69	....	....	....	21.30	December 15	42.16	....	20.66	38.43	38.56
June 23	....	18.76	6.37	23.64	23.70	December 22	43.53	26.84	20.68	39.41	....
June 30	....	....	6.45	....	24.06	December 29	....	27.59	....	40.21	39.43

Table 5.—Average weekly relative humidity at Temple, 1923-1927*

Week Ending	Relative Humidity					Week Ending	Relative Humidity				
	1923	1924	1925	1926	1927		1923	1924	1925	1926	1927
January 7	63.5	66.1	55.6	93.4	74.1	July 7	70.3	58.2	50.4	77.3	76.6
January 14	66.6	63.7	65.4	78.7	75.3	July 14	70.8	61.0	48.6	76.7	69.2
January 21	75.5	80.8	80.7	89.2	87.5	July 21	64.7	60.9	49.4	79.7	66.7
January 28	86.5	83.8	70.8	91.1	91.7	July 28	66.1	53.1	47.1	71.2	78.6
February 4	80.4	60.9	61.4	84.2	83.7	August 4	69.2	60.0	62.1	72.5	71.1
February 11	88.9	68.0	58.0	80.5	96.3	August 11	62.1	57.2	57.8	76.5	66.1
February 18	84.9	79.5	49.0	80.5	71.8	August 18	69.3	57.5	62.6	69.6	60.5
February 25	87.9	84.9	57.6	74.5	69.2	August 25	75.0	59.6	61.6	83.7	66.5
March 3	82.9	74.2	49.4	75.8	80.2	September 1	88.2	65.4	74.6	83.4	60.5
March 10	72.5	72.2	49.4	87.5	82.5	September 8	80.4	51.0	56.9	74.0	69.0
March 17	62.0	83.0	50.7	89.2	68.5	September 15	86.9	78.7	78.4	63.6	73.5
March 24	68.3	75.0	45.2	89.6	74.1	September 22	84.9	75.7	68.7	79.7	71.3
March 31	84.1	68.7	45.4	90.3	77.5	September 29	78.2	67.0	80.0	70.5	78.0
April 7	79.6	62.2	54.2	88.5	79.2	October 6	79.0	70.6	76.5	82.0	89.1
April 14	86.7	77.0	45.6	86.3	78.0	October 13	74.9	70.6	83.5	82.3	85.4
April 21	83.2	61.6	49.1	82.8	82.3	October 20	76.6	69.5	77.3	86.9	79.8
April 28	82.8	78.1	64.7	91.9	74.7	October 27	88.6	57.3	82.9	77.2	78.6
May 5	75.1	70.5	51.8	80.9	71.2	November 3	80.1	61.4	86.6	85.5	86.9
May 12	72.3	72.1	63.6	79.7	81.0	November 10	80.1	71.4	90.8	62.1	87.2
May 19	76.2	70.0	55.7	75.9	76.7	November 17	84.0	73.1	84.4	77.6	83.1
May 26	75.2	78.3	53.5	84.0	74.1	November 24	84.0	67.6	84.8	68.7	80.3
June 2	80.1	83.8	55.7	73.8	67.4	December 1	86.5	62.4	81.4	90.2	80.2
June 9	75.5	64.9	57.6	71.3	77.1	December 8	82.5	65.2	77.6	87.8	74.0
June 16	75.9	63.3	56.1	80.7	85.6	December 15	90.4	79.5	79.9	88.6	84.7
June 23	71.7	73.5	52.9	72.1	83.1	December 22	89.8	82.6	80.3	99.7	82.9
June 30	80.7	65.0	48.4	68.5	81.7	December 29	92.8	82.6	81.4	99.7	93.7

*Calculated from daily meteorological records at Substation No. 5.

Table 6.—Weekly mean temperature at Temple, 1923-1927*

Week Ending	Mean Air Temperature					Week Ending	Mean Air Temperature				
	1923	1924	1925	1926	1927		1923	1924	1925	1926	1927
January 7	53.0	33.8	47.4	45.3	54.2	July 7	77.6	75.3	87.9	84.2	82.2
January 14	56.5	38.3	46.6	40.7	46.3	July 14	82.9	84.7	88.0	84.2	83.1
January 21	57.6	41.5	43.9	52.4	50.3	July 21	81.9	86.2	89.7	80.9	87.0
January 28	55.2	46.6	47.8	35.2	45.2	July 28	84.1	86.0	89.6	82.0	82.7
February 4	56.1	58.9	53.4	55.3	61.0	August 4	84.8	86.3	80.1	85.1	86.2
February 11	38.8	48.8	60.4	54.2	53.5	August 11	83.2	87.0	82.9	85.9	87.4
February 18	47.3	54.6	54.2	59.2	58.9	August 18	85.1	86.7	88.1	75.3	85.6
February 25	52.2	43.1	64.4	56.9	55.0	August 25	80.1	87.9	84.2	83.0	82.1
March 3	57.9	48.4	50.1	54.1	47.8	September 1	79.7	86.0	82.8	80.5	86.7
March 10	57.5	52.0	69.5	55.8	61.2	September 8	74.6	79.5	84.0	83.4	83.7
March 17	50.9	45.5	64.4	51.2	61.8	September 15	75.1	77.2	81.3	83.2	83.5
March 24	51.7	49.1	62.8	64.5	56.1	September 22	72.9	78.5	84.2	82.0	74.2
March 31	54.1	66.6	71.7	47.9	69.8	September 29	75.6	71.2	75.7	77.9	71.5
April 7	65.6	59.5	69.0	59.3	73.5	October 6	67.2	71.9	80.4	76.6	77.3
April 14	61.8	66.4	73.8	58.2	71.1	October 13	64.6	73.0	68.4	78.1	65.7
April 21	59.4	67.8	80.6	65.9	67.2	October 20	57.5	68.0	62.1	72.2	64.5
April 28	71.7	71.7	75.8	75.6	66.0	October 27	49.6	56.0	61.6	65.2	69.8
May 5	67.0	66.2	67.0	70.8	74.0	November 3	50.9	66.3	50.9	57.7	67.7
May 12	69.2	65.9	74.3	73.4	72.8	November 10	52.4	64.5	56.5	52.7	71.7
May 19	72.3	71.5	80.9	67.2	77.0	November 17	60.8	68.4	57.4	56.3	55.9
May 26	74.6	75.3	77.8	75.6	80.5	November 24	62.6	56.7	52.3	53.5	64.4
June 2	78.5	75.3	80.7	78.9	82.1	December 1	54.1	53.8	57.2	52.7	61.3
June 9	78.5	80.1	84.9	78.3	77.5	December 8	57.6	63.7	51.6	57.5	41.7
June 16	79.8	84.6	87.2	84.9	77.0	December 15	45.1	50.0	51.5	44.0	57.0
June 23	79.5	80.8	87.6	83.3	79.5	December 22	50.6	43.0	40.4	54.0	36.7
June 30	79.2	83.7	85.2	81.1	80.6	December 29	59.3	37.1	44.7	41.5	51.0

*Calculated from daily meteorological records at Substation No. 5.